ANALYSIS AND DESIGN SOFTWARE FOR RADIAL SLOT ANTENNAS

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Abstract

Software for the analysis and design of radial slot antennas excited by one or several coaxial probes is presented. This tool has two main different blocks: analysis and design. The software has been improved with a file input/output options and a graphic display of radiation patterns, impedance, directivity and other antenna parameters. Everything is compiled in C++ for Windows. The second part of the paper includes some designs and results.

I. *Introduction*

This kind of antenna has been studied by some electromagnetic groups throughout the world for the last years [1-3], and this software can be a helpful tool for the improvements in the design of these antennas.

The software is based a multiport model developed by the authors [4]. Before implementing this model we have correlated our results with some measurements and with the results of Moment Method analysis for small structures.

The program, compiled in Borland C++ 4.5 for Windows 95 runs on an IBM-Compatible personal computer with 486 or Pentium processor, 16 MB RAM minimum (32 or more recommended) and VGA card.

For large antenna design, this software improves the time response achieved by other Electromagnetic Software of general purpose.

Previously, the DBS receiver antenna shown in Figure 1 was designed and we got a very good concordance between the measurements and the predicted values. These results were better for the copolar components than for the crosspolar ones and the values predicted for the angles closer to the main lobe were very accurate [5]. Now, we are in the construction step of an antenna fed by four coaxial probes, designed with this software.

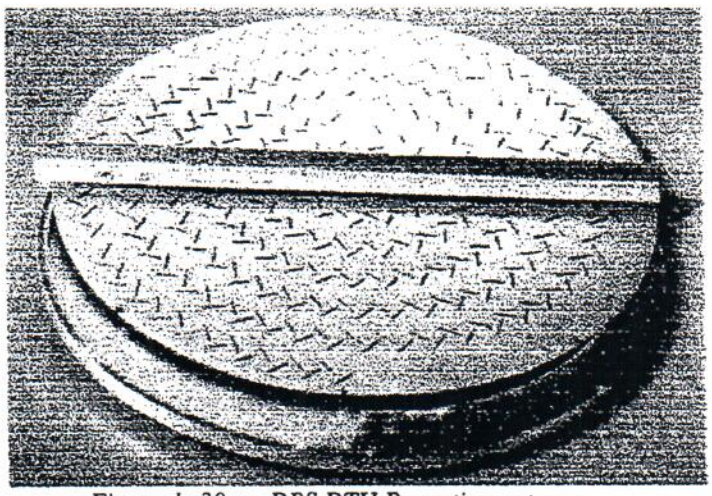

Figure 1: 30 cm DBS DTH Reception antenna

2. *Software features*

The software is divided in six blocks as shown in Figure 2.

User interface:

The user can select the feeding type of the antenna, the polarization (left-hand, right-hand or linear), the electrical and mechanical parameters of the parallel plates and the parameters of the coaxial probe(s). The user can also select the beam tilting of the antenna.

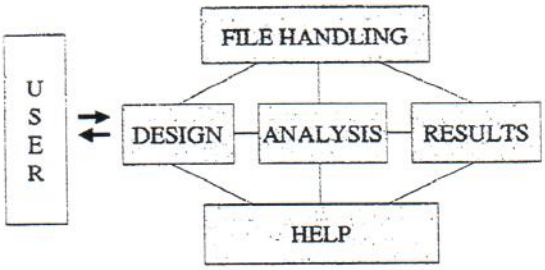

Figure 2: Software Blocks

Design Block:

The design block lets the user to design radial slot antennas with a circular shape. Design models for linear and circular polarizations have been developed. For this last one we have developed the possibility of exciting the antenna with one or four coaxial probes. For circular polarization we have introduced the possibility of beam tilting. The design block is based on the studies presented in [1-3] and on the results obtained with the analysis block. The data for the design can be introduced by the user interface or by an input file. Figure 3 shows the design of a radial slot antenna excited by four coaxial probes. A LHCP main beam in the broadside direction is obtained.

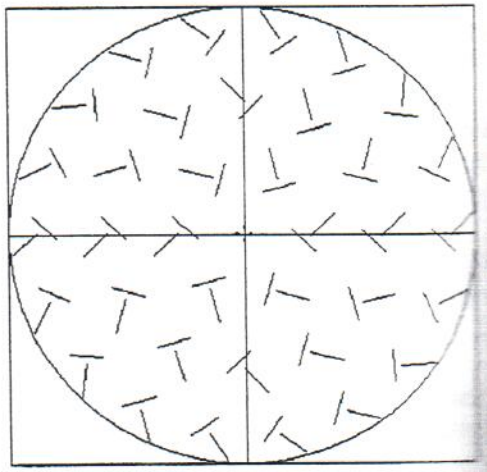

Figure 3: Design of an antenna.

Analysis Block:

The analysis is based on the theory shown in [4], where closed form formulas were derived to model the slot antenna as a multiport network. The ports of the network are the slots, the coaxial probes and several short circuit probes used to simulate the short circuit wall [6]. The coupling coefficients among all the them are estimated from the far-field theory and the propagation of the first mode although there are some parameters that have been adjusted. This method and the comparison with a Moment Method Analysis and with some antennas measurements are shown in [4].

The analysis block is independent of the design one. Any other different slot/probe arrangements can be analyzed by introducing the antenna structure in file format. This facility is useful in the design of some large antenna structures.

Results Block:

The numerical and plotted results offered by the software are:
- Radiation Pattern for a fixed frequency.
- Standing Wave Ratio vs. frequency.
- Gain or Directivity vs. frequency.
- Electric field (amplitude an phase) on each slot.

All the ranges of the plotted results are introduced by the user in the following form: minimum value, maximum value and number of steps. The time required for the program to analyze the antenna is proportional to the number of selected frequencies.

File Handling:

The design, analysis and results are stored in a text file. The user can read it with any text processor or create new designs, different than the ones proposed by the program, to analyze transformed antenna structures with the analysis block.

There is a help menu available at any moment that gives a complete index of the program options. It displays the explanation for each option separately.

3. *Antenna Designs*

Two designs obtained with this software are shown herein. Some of the corresponding analysis results are also presented as the software displays them (Spanish version).

Circular polarization tilted beam antenna.

The first antenna is a spiral antenna fed by one coaxial probe in the center that produces a LHCP 10° tilted beam. The antenna geometry and the copolar/crosspolar antenna pattern (obtained with the software) are shown in Fig. 4 and 5, respectively.

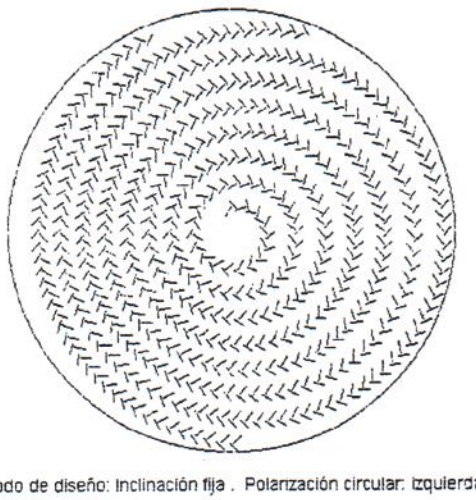

Figure 4: Design of the antenna

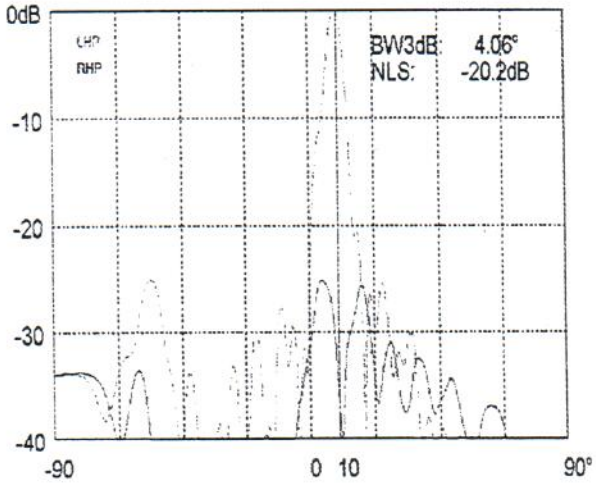

Figure 5: Radiation Pattern

Circular Polarization broadside spiral antenna.

The second design presented is a LHCP broadside Archimedian Spiral slot antenna (Fig.6) whose gain to frequency plot is shown in Fig.7.

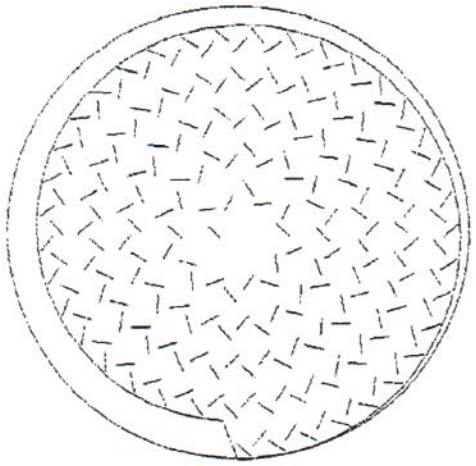

Figure 6: Spiral Broadside Antenna

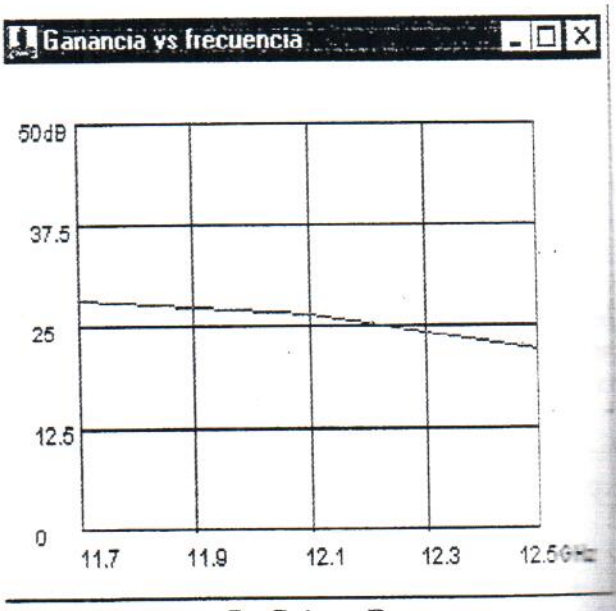

Figure 7: Gain vs Frequency

Conclusions

A set of software tools useful for the design of radial line slotted antennas is presented. It can be used for analyzing any other antenna configurations to implement new designs. This software has been validated with some prototypes measurements that agree well with the predicted results.

References

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